



# ***NDCEE***

National Defense Center for Energy and Environment

## **Demonstration of a Lead-free Surveillance Program for RoHS Lead- free Risks**



**DoD Executive Agent**

Office of the  
Assistant Secretary  
of the Army  
(Installations and  
Environment)

**E2S2 Conference  
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The NDCEE is operated by:  *Concurrent Technologies Corporation*

**Technology Transition – Supporting DoD Readiness, Sustainability, and the Warfighter**

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## Background

- Following the European Union's Restriction of Hazardous Substances (RoHS) Directive, many industry suppliers are eliminating lead (Pb) in solder, electronic components, and circuit board finishes.
- There are no requirements for electronic component manufacturers to change their labeling to differentiate between traditionally processed devices and those processed using Pb-free technologies.
- Pb-free electronics (solder, component finishes, printed wiring boards [PWBs], etc.) bring new failure modes in electronics
  - Pb-free has caused short-circuiting and electronic failures from the formation of tin whiskers



## Background (continued)

- Many military specifications (Mil-Specs) require that coatings for electronic components contain at least 3% Pb and be at least 200  $\mu$ in-inch thick for tin-lead plate.
- Currently, the DoD is unable to measure and verify the Pb content of incoming electronic components on a large scale or determine the prevalence of unauthorized Pb-free components in the acquisition supply chain.
- Given the RoHS directive, there is concern that Pb-free components will be integrated into critical DoD weapon systems on an increasing basis.



# Background (Continued)

## Dangerous Fakes (BusinessWeek Oct. 2, 2008)

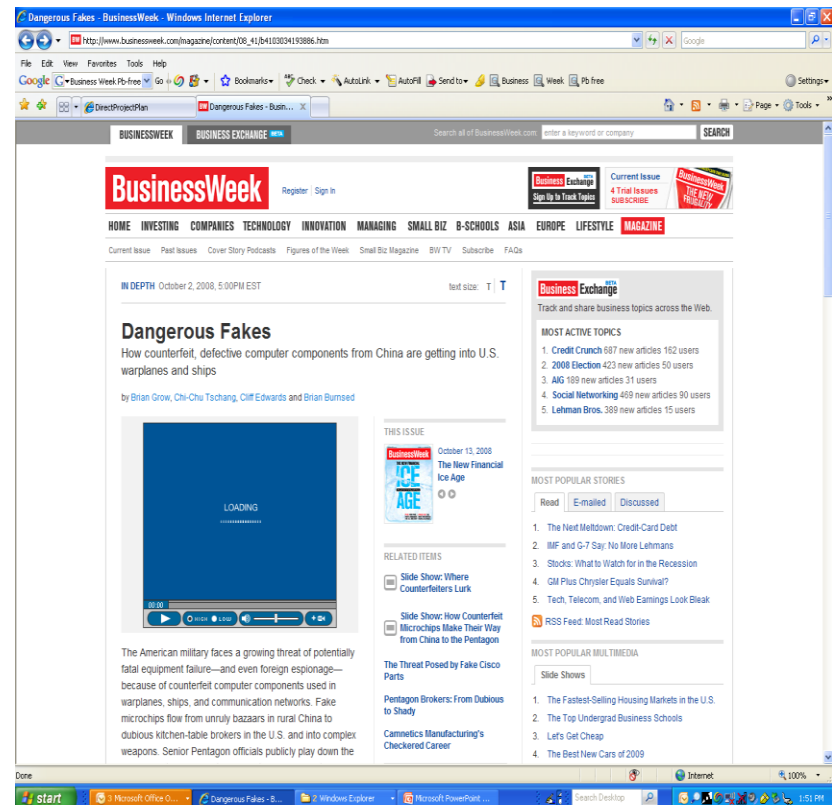
*How counterfeit, defective computer components from China are getting into U.S. warplanes and ships*

by [Brian Grow](#), [Chi-Chu Tschang](#), [Cliff Edwards](#) and [Brian Burnsed](#)

*“...officials at the Defense Supply Center in Columbus, Ohio—a major Pentagon electronic-parts buyer—said they don't inspect brokers or conduct background checks...”*

*“...Suppose that a part like that makes it onto a flight-critical piece of hardware or mission-essential piece of hardware. The[re] is a very good chance that the part may work...but what happens at 40[,000] ft and -50 degrees? Hardware failure. Not good.” ...*

# BusinessWeek



# Approach

- The objective of the NDCEE Pb-free efforts is to help the DoD face potential failure modes in mission critical electronics including high reliability systems.
- The NDCEE, under the technical direction of the Aviation and Missile Command (AMCOM) G-4, is working to address the Pb-free issue:
  - A demonstration/validation (dem/val) at Tobyhanna Army Depot (TYAD) to evaluate of X-Ray Fluorescence (XRF) technology – completed June 30, 2008.
  - The development of a database, the Lead-Free Surveillance and Analysis System (LSAS), to provide access to reliable information on Pb-free data to the DoD, subcontractors, and OEMs.
  - A dem/val of XRF technology within Fort Rucker programs.
  - The development of a Pb-free Training Program to be hosted on the Defense Acquisition University (DAU) website.

# Purpose and Accomplishments

- Purpose:
  - Evaluate the performance of XRF technology in analyzing Pb content of electronics in a realistic and active Army depot environment
  - Evaluate the XRF accuracy and reliability in a production environment
  - Determine practical value of placing similar XRF units in other DoD installations
- XRF dem/val at TYAD:
  - Evaluated the XRF technology in a production setting and determined that XRF can effectively assist military installations in identifying the content of solder joints and component finishes
- LSAS:
  - Created a central repository of information for Pb-free solder and electronic components in the military supply chain



**Photo of XRF unit in place at TYAD**

# Accomplishments

- As part of the down-select process, the stakeholder team created a list of performance requirements and design specifications, including:
  - Collimator size
  - Detection range to include relevant atomic weights
  - Stage movement
  - Layer discrimination and element composition simultaneously.
- The team contacted vendors and reviewed various units including the Fischer Technology, Inc. Fischerscope XDAL XRF spectrometer, which was selected as the XRF unit that best met the identified specifications.



# XRF Dem/Val Details

- Three XRF units were evaluated in the following locations at TYAD:
  - Central Receiving for screening incoming electronic parts
  - Q36/37 Firefinder Components area for screening new and inventoried parts
  - C3/Avionics Flight Control Branch for screening new and inventoried parts.
- A 90-day dem/val was completed June 30, 2008.
- TYAD staff scanned new (from receiving) and old (from inventory) electronic components and collected data from XRF analysis.
- The project team evaluated performance using a set of criteria established in the planning stages of the dem/val.

# XRF Dem/Val Details (continued)

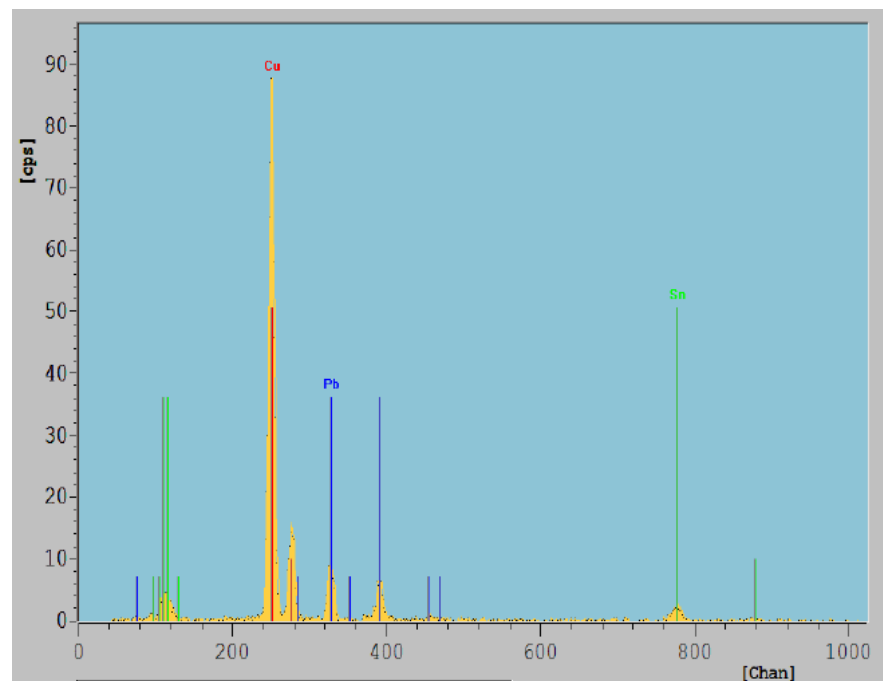
- Data and findings from the TYAD XRF dem/val project have been shared with the DoD community.
  - Potential Pb-free prevalence in the military supply chain (findings from XRF data show ~30% Pb-free)
  - Component finish thicknesses do not meet Mil Specs

# XRF Findings

- Estimated instrument uncertainty is  $\pm 10\%$  for each reading
  - Factor of certified standards, equipment calibration, and measurement errors
  - Experts cannot quantify an acceptable error level
- XRF technology is useful as a tolerance screening tool
  - Dem/val method configured to screen for 4% Pb level
  - Allowed for quick inventory screening
  - Most electronic component finishes contained either no Pb or Pb levels much higher than 3%
  - Mil Spec compliance was easy to identify, regardless of actual instrument uncertainty

# XRF Findings (continued)

- Operation of XRF units required some knowledge of components and understanding of the technology
  - Set-up parameters/configuration
  - Misidentification of unknown materials
  - When in doubt, look at spectrum and identify peaks



# XRF Dem/Val Summary and Path Forward

- Technology transfer at TYAD is complete. TYAD is retaining two Fischerscope XDAL XRF units and purchasing others.
- TYAD is the first Army Depot to take action against the integration of Pb-free components in the military supply chain.
- Now that the Pb-free problem has been identified, TYAD needs to develop a Pb-free control plan to mitigate it.
- Other DoD facilities could benefit from the analytical capabilities of XRF technology.
- NDC EE is working with Fort Rucker, AL to dem/val and transition XRF technology there.

# LSAS Details

- LSAS can be accessed by multiple users for different purposes, including:
  - Data Input: Users can enter or edit data about parts, ranging from manufacturer details to scanned composition to part failure analysis.
  - Data Review: Users can search and view existing data.
  - Data Reports: Users can create and save reports or export search results.
- LSAS users have access to data provided by the Federal Logistics Information System (FLIS).

# LSAS Details

- FLIS is a free service provided to the DoD.
  - Information provided by FLIS includes a look-up feature that ensures a high level of data accuracy by allowing for automated form completion.
- LSAS contains part data generated from scanning electronic components using XRF technology.
- Data collected from the XRF dem/val at Tobyhanna Army Depot populated the LSAS.

# LSAS Details

- Data contained within the LSAS includes:
  - Part Number
  - National Stock Number (NSN)
  - CAGE Code
  - Solder/Finish Content (if available, determined from XRF unit or similar output)
  - Date Scanned (if available, determined from XRF unit or similar output)
  - Nomenclature
  - Distributor
  - Manufacturer
  - Contract Number.



# LSAS Search Page



**LSAS**  
LEAD-FREE SURVEILLANCE AND ANALYSIS SYSTEM

Welcome User Admin [\[Edit Profile\]](#)

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## Basic Search [\[Advanced Search\]](#)

Part Number:

Component Type:


All Component Types

NSN:

### Include in Search Results

- |   |   |  |  |
|---|---|--|--|
| <input checked="" type="checkbox"/> Part Number | <input type="checkbox"/> Solder Content         | <input type="checkbox"/> J Standard 609          | <input type="checkbox"/> Base Metal Content      |
| <input type="checkbox"/> Metal Content          | <input checked="" type="checkbox"/> Part Type   | <input type="checkbox"/> Order Quantity          | <input type="checkbox"/> Manufacturer            |
| <input type="checkbox"/> Area Scanned           | <input type="checkbox"/> Contract Number        | <input checked="" type="checkbox"/> CAGE Code    | <input type="checkbox"/> Date Scanned            |
| <input type="checkbox"/> Batch/Bin Number       | <input checked="" type="checkbox"/> NSN         | <input checked="" type="checkbox"/> Nomenclature | <input type="checkbox"/> Lot Number              |
| <input type="checkbox"/> Serial Number          | <input type="checkbox"/> Component Lead Content | <input type="checkbox"/> Distributor             | <input type="checkbox"/> Meets PB Specifications |

# Output from One Record in LSAS


**LSAS**  
LEAD-FREE SURVEILLANCE AND ANALYSIS SYSTEM

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### View Record:

**LAST Record: TYAD2008CR00027**

Paul Mack entered this record.  
User Admin was the last to update this record.

**Sampling Info:**  
 Lot Size: 25  
 Sample Size: 5

<b>Part Info:</b> Part Type: Resistor Part Number: 852D572G2 NSN: 5915000137610 Nomenclature: CAPACITOR-RESISTOR Serial Number: J-Standard-609 e1 Marking Code:	<b>Manufacturing Info:</b> CAGE: 89954 Manufacturer: BAE SYSTEMS CONTROLS INC. Manufacturer Address: 600 MAIN STREET JOHNSON CITY, New York 13790 UNITED STATES
<b>Order Info:</b> Purchase Order Number: Order Quantity: 25 WG1V Number: Contract Number: Lot Number: Batch/Bin Number: Distributor:	<b>Miscellaneous Info:</b> Comments: Testing comment save.

**XRF Scan Data:**  
 Is Component Lead-free?: No

Component Solder Composition					Component Base Metal Composition							
Solder Thickness	Tin (Ag)	Silver (Sn)	Lead (Pb)	Bismuth (Bi)	Copper (Cu)	Iron (Fe)	Cobalt (Co)	Zinc (Zn)	Gold (Au)	Palladium (Pd)	Nickel	Aluminium (Al)
N/A	0.64393	70.55275	30.09418	N/A	99.1498	0.76929	0.01407	0.06685	N/A	N/A	N/A	N/A
N/A	1.21399	70.08755	28.68974	0.00873	101.006523	N/A	0.14526	N/A	N/A	N/A	N/A	N/A
N/A	0.65291	70.46783	29.17473	N/A	101.531342	N/A	0.01299	N/A	N/A	N/A	N/A	N/A
N/A	N/A	72.70572	27.50106	0.27512	99.36807	N/A	0.76927	0.07457	N/A	N/A	N/A	N/A

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# LSAS Path Forward

- AMCOM G4 is overseeing the final transition of LSAS. This database will assist the PEOS and subordinate PMs that are all part of the LCMC.
- The LSAS is hosted internally for an interim period. Technology transfer of the LSAS is expected to occur in 2009.

# Pb-free Training

- The Defense Microelectronics Activity (DMEA) is supporting the development of Pb-free Training and its transition to the Defense Acquisition University (DAU) website.
- This training will assist individuals in building their knowledge base in a number of areas related to Pb-free:
  - Lead-free Transition Drivers and Impacts
  - Lead-free Failure Modes (Tin Whisker Characteristics)
  - DoD's Pb-free Strategy
  - Government Electronics and Information Technology Association (GEIA) Pb-free Standards and Handbooks.
- The training will be transitioned and hosted on the DAU website and ultimately be expanded to include additional training modules.

# Project Stakeholders

- Aviation and Missile Command (AMCOM) G-4
- Defense Microelectronics Activity (DMEA)
- National Aeronautics and Space Administration (NASA)
- Naval Air Systems Command (NAVAIR)
- Fort Rucker, AL
- Letterkenny Army Depot, PA
- Office of the Assistant Secretary of the Army, Acquisition, Logistics, and Technology (ASA(ALT))
- Tobyhanna Army Depot, PA
- U.S. Army Aviation & Missile Research Development and Engineering Command (AMRDEC)
- U.S. Army Communications-Electronics Command (CECOM) Life Cycle Management Command (LCMC)
- U.S. Army Communications-Electronics Research & Development Engineering Center (CERDEC)

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